N° XXXVIII.

A Letter from Dr. BENJAMIN FRANKLIN, *to* Mr. ALPHONSUS le ROY, *Member of ſeveral Academies, at Paris. Containing ſundry Maritime Obſervations.*

At Sea, on board the London Packet, Capt. Truxton, Auguſt 1785.

SIR,

Read Dec. 2, 1785.

YOUR learned writings on the navigation of the antients, which contain a great deal of curious information; and your very ingenious contrivances for improving the modern ſails (*voilure*) of which I ſaw with great pleaſure a ſucceſsful trial on the river Seine, have induced me to ſubmit to your conſideration and judgment, ſome thoughts I have had on the latter ſubject.

Thoſe mathematicians who have endeavoured to improve the ſwiftneſs of veſſels, by calculating to find the form of leaſt reſiſtance, ſeem to have conſidered a ſhip as a body moving through one fluid only, the water; and to have given little attention to the circumſtance of her moving through another fluid, the air. It is true that when a veſſel ſails right before the wind, this circumſtance is of no importance, becauſe the wind goes with her; but in every deviation from that courſe, the reſiſtance of the air is ſomething, and becomes greater in proportion as that deviation increaſes. I wave at preſent the conſideration of thoſe different degrees of reſiſtance given by the air to that part of the hull which is above water, and confine myſelf to that given to the ſails; for their motion through the air is reſiſted by the air, as the motion of the hull through the water is reſiſted by the water, though with leſs force as the air is a lighter fluid. And to ſimplify the diſcuſſion as much as poſſible, I would ſtate one ſituation only, to wit, that of the wind upon the beam, the ſhip's courſe being directly acroſs the wind; and I would ſuppoſe

facing page 294.

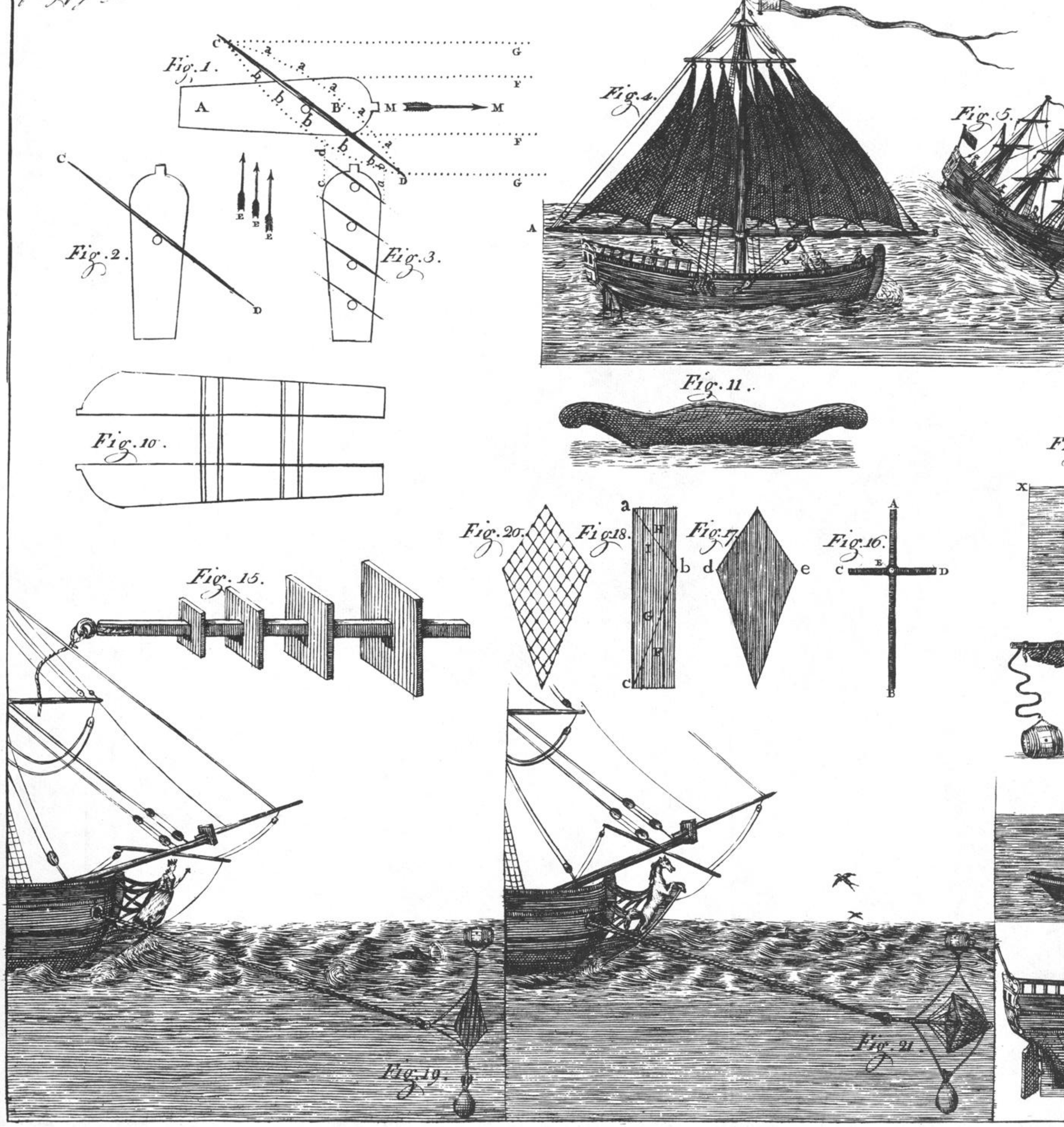

Plate.4.

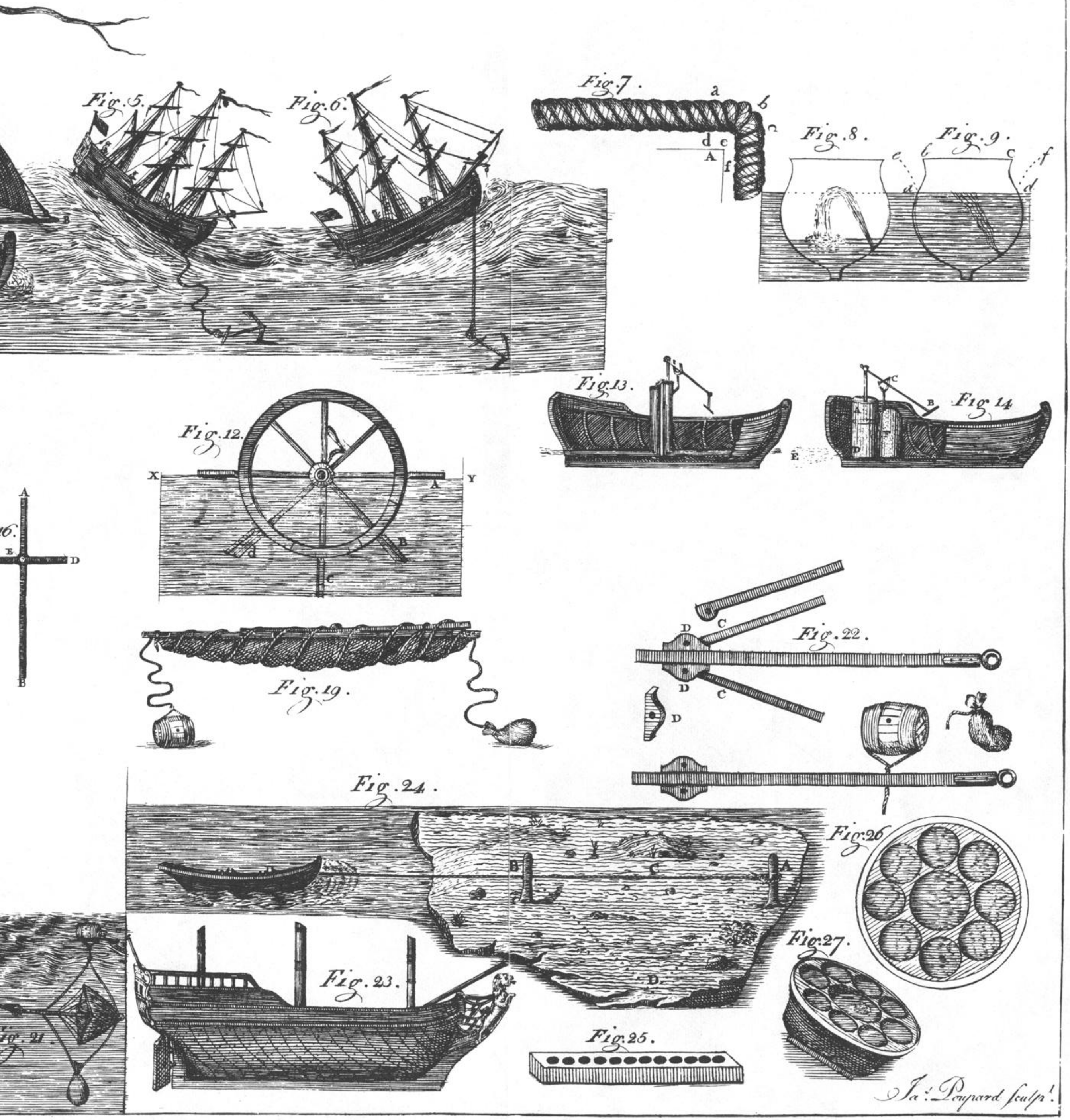
Fig.5.
Fig.6.
Fig.7.
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b
c
d
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Fig.8.
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Fig.9.
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Fig.12.
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Fig.13.
Fig.14.
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Fig.19.
Fig.22.
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Fig.24.
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Fig.26.
Fig.27.
Fig.23.
Fig.25.
Fig.21.
Ja.s Poyard sculp.t

ſuppoſe the ſail ſet in an angle of 45 degrees with the keel, as in the following figure; wherein

A B repreſents the body of the veſſel, CD the poſition of the ſail, EEE the direction of the wind, MM the line of motion. In obſerving this figure it will appear, that ſo much of the body of the veſſel as is immerſed in the water, muſt, to go forward, remove out of its way what water it meets with between the pricked lines F F. And the ſail, to go forward, muſt move out of its way all the air its whole dimenſion meets with between the pricked lines CG and DG. Thus both the fluids give reſiſtance to the motion, each in proportion to the quantity of matter contained in the dimenſion to be removed. And though the air is vaſtly lighter than the water, and therefore more eaſily removed, yet the dimenſion being much greater its effect is very conſiderable.

Plate IV. Figure 1.

It is true that in the caſe ſtated, the reſiſtance given by the air between thoſe lines to the motion of the ſail is not apparent to the eye, becauſe the greater force of the wind which ſtrikes it in the direction E E E, overpowers its effect, and keeps the ſail full in the curve a, a, a, a, a. But ſuppoſe the wind to ceaſe, and the veſſel in a calm to be impelled with the ſame ſwiftneſs by oars, the ſail would then appear filled in the contrary curve b, b, b, b, b, when prudent men would immediately perceive that the air reſiſted its motion, and would order it to be taken in.

Is there any poſſible means of diminiſhing this reſiſtance, while the ſame quantity of ſail is expoſed to the action of the wind, and therefore the ſame force obtained from it? I think there is, and that it may be done by dividing the ſail into a number of parts, and placing thoſe parts in a line one behind the other; thus inſtead of one ſail extending from C to D, figure 2, if four ſails containing together the ſame quantity of canvas, were placed as in figure 3, each having one quarter of the di-

menſions of the great ſail, and expoſing a quarter of its ſurface to the wind, would give a quarter of the force; ſo that the whole force obtained from the wind would be the ſame, while the reſiſtance from the air would be nearly reduced to the ſpace between the pricked lines *a b* and *c d*, before the foremoſt ſail.

It may perhaps be doubted whether the reſiſtance from the air would be ſo diminiſhed; ſince poſſibly each of the following ſmall ſails having alſo air before it, which muſt be removed, the reſiſtance on the whole would be the ſame.

This is then a matter to be determined by experiment. I will mention one that I many years ſince made with ſucceſs for another purpoſe; and I will propoſe another ſmall one eaſily made. If that too ſucceeds, I ſhould think it worth while to make a larger, though at ſome expence, on a river boat; and perhaps time and the improvements experience will afford, may make it applicable with advantage to larger veſſels.

Having near my kitchen chimney a round nole of eight inches diameter, through which was a conſtant ſteady current of air, increaſing or diminiſhing only as the fire increaſed or diminiſhed, I contrived to place my jack ſo as to receive that current; and taking off the flyers, I fixed in their ſtead on the ſame pivot a round tin plate of near the ſame diameter with the hole; and having cut it in radial lines almoſt to the centre, ſo as to have ſix equal vanes, I gave to each of them the obliquity of forty-five degrees. They moved round, without the weight, by the impreſſion only of the current of air, but too ſlowly for the purpoſe of roaſting. I ſuſpected that the air ſtruck by the back of each vane might poſſibly by its reſiſtance retard the motion; and to try this, I cut each of them into two, and I placed the twelve, each having the ſame obliquity, in a line behind each other, when I perceived a great augmentation in its velocity, which encouraged me to di-

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vide them once more, and, continuing the ſame obliquity, I placed the twenty-four behind each other in a line, when the force of the wind being the ſame, and the ſurface of vane the ſame, they moved round with much greater rapidity, and perfectly anſwered my purpoſe.

The ſecond experiment that I propoſe, is, to take two playing cards of the ſame dimenſions, and cut one of them tranſverſely into eight equal pieces; then with a needle ſtring them upon two threads one near each end, and place them ſo upon the threads that, when hung up, they may be one exactly over the other, at a diſtance equal to their breadth, each in a horizontal poſition; and let a ſmall weight, ſuch as a bird-ſhot, be hung under them, to make them fall in a ſtraight line when let looſe. Suſpend alſo the whole card by threads from its four corners, and hang to it an equal weight, ſo as to draw it downwards when let fall, its whole breadth preſſing againſt the air. Let thoſe two bodies be attached, one of them to one end of a thread a yard long, the other to the other end. Extend a twine under the ceiling of a room, and put through it at thirty inches diſtance two pins bent in the form of fiſh-hooks. On theſe two hooks hang the two bodies, the thread that connects them extending parallel to the twine, which thread being cut, they muſt begin to fall at the ſame inſtant. If they take equal time in falling to the floor, it is a proof that the reſiſtance of the air is in both caſes equal. If the whole card requires a longer time, it ſhows that the ſum of the reſiſtances to the pieces of the cut card is not equal to the reſiſtance of the whole one*.

This principle ſo far confirmed, I would proceed to make a larger experiment, with a ſhallop, which I would rig in this manner.

A B is

* The motion of the veſſel made it inconvenient to try this ſimple experiment, at ſea, when the propoſal of it was written. But it has been tried ſince we came on ſhore, and ſucceeded as the other.

Plate IV. Figure 4. A B is a long boom, from which are hoifted feven jibs, a, b, c, d, e, f, g, each a feventh part of the whole dimenfions, and as much more as will fill the whole fpace when fet in an angle of forty-five degrees, fo that they may lap when going before the wind, and hold more wind when going large. Thus rigged, when going right before the wind, the boom fhould be brought at right angles with the keel, by means of the fheet ropes C D, and all the fails hauled flat to the boom.

Thefe pofitions of boom and fails to be varied as the wind quarters. But when the wind is on the beam, or when you would turn to windward, the boom is to be hauled right fore and aft, and the fails trimmed according as the wind is more or lefs againft your courfe.

It feems to me that the management of a fhallop fo rigged would be very eafy, the fails being run up and down feparately, fo that more or lefs fail may be made at pleafure; and I imagine, that there being full as much fail expofed to the force of the wind which impells the veffel in its courfe, as if the whole were in one piece, and the refiftance of the dead air againft the forefide of the fail being diminifhed, the advantage of fwiftnefs would be very confiderable; befides that the veffel would lie nearer the wind.

Since we are on the fubject of improvements in navigation, permit me to detain you a little longer with a fmall relative obfervation. Being, in one of my voyages, with ten merchant-fhips under convoy of a frigate at anchor in Torbay, waiting for a wind to go to the weftward; it came fair, but brought in with it a confiderable fwell. A fignal was given for weighing, and we put to fea all together; but three of the fhips left their anchors, their cables parting juft as the anchors came a-peak. Our cable held, and we got up our anchor; but the fhocks the fhip felt before the anchor got loofe from the ground, made me reflect on what might poffibly have caufed the break-

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ing of the other cables; and I imagined it might be the ſhort bending of the cable juſt without the hauſe-hole, from a horizontal to an almoſt vertical poſition, and the ſudden violent jerk it receives by the riſing of the head of the ſhip on the ſwell of a wave while in that poſition. For example, ſuppoſe a veſſel hove up ſo as to have her head nearly over her anchor, which ſtill keeps its hold, perhaps in a tough bottom; if it were calm, the cable ſtill out would form nearly a perpendicular line, meaſuring the diſtance between the hauſe-hole and the anchor; but if there is a ſwell, her head in the trough of the ſea will fall below the level, and when lifted on the wave will be as much above it. In the firſt caſe the cable will hang looſe and bend perhaps as in figure 5. In the ſecond caſe figure 6, the cable will be drawn ſtraight with a jerk, muſt ſuſtain the whole force of the riſing ſhip, and muſt either looſen the anchor, reſiſt the riſing force of the ſhip, or break. But why does it break at the hauſe-hole?

Let us ſuppoſe it a cable of three inches diameter, and repreſented by figure 7. If this cable is to be bent round the corner A, it is evident that either the part of the triangle contained between the letters a, b, c, muſt ſtretch conſiderably, and thoſe moſt that are neareſt the ſurface; or that the parts between d, e, f, muſt be compreſſed; or both, which moſt probably happens. In this caſe the lower half of the thickneſs affords no ſtrength againſt the jerk, it not being ſtrained, the upper half bears the whole, and the yarns near the upper ſurface being firſt and moſt ſtrained, break firſt, and the next yarns follow; for in this bent ſituation they cannot bear the ſtrain all together, and each contribute its ſtrength to the whole, as they do when the cable is ſtrained in a ſtraight line.

To remedy this, methinks it would be well to have a kind of large pulley wheel, fixed in the hauſe-hole, ſuppoſe of two feet diameter, over which the cable might paſs; and being there bent gradually to the round of the wheel,

wheel, would thereby be more equally ſtrained, and better able to bear the jerk, which may ſave the anchor, and by that means in the courſe of the voyage may happen to ſave the ſhip.

One maritime obſervation more ſhall finiſh this letter. I have been a reader of news-papers now near ſeventy years, and I think few years paſs without an account of ſome veſſel met with at ſea, with no ſoul living on board, and ſo many feet of water in her hold, which veſſel has nevertheleſs been ſaved and brought into port: and when not met with at ſea, ſuch forſaken veſſels have often come aſhore on ſome coaſt. The crews who have taken to their boats and thus abandoned ſuch veſſels, are ſometimes met with and taken up at ſea by other ſhips, ſometimes reach a coaſt, and are ſometimes never heard of. Thoſe that give an account of quitting their veſſels, generally ſay, that ſhe ſprung a leak, that they pumped for ſome time, that the water continued to riſe upon them, and that deſpairing to ſave her, they had quitted her leſt they ſhould go down with her. It ſeems by the event that this fear was not always well founded, and I have endeavoured to gueſs at the reaſon of the people's too haſty diſcouragement.

When a veſſel ſprings a leak near her bottom, the water enters with all the force given by the weight of the column of water, without, which force is in proportion to the difference of level between the water without and that within. It enters therefore with more force at firſt, and in greater quantity, than it can afterwards when the water within is higher. The bottom of the veſſel too is narrower, ſo that the ſame quantity of water coming into that narrow part, riſes faſter than when the ſpace for it to flow in is larger. This helps to terrify. But as the quantity entering is leſs and leſs as the ſurfaces without and within become more nearly equal in height, the pumps that could not keep the water from riſing at firſt, might afterwards be able to prevent its riſing higher, and the people might

might have remained on board in ſafety, without hazarding themſelves in an open boat on the wide ocean. (Fig. 8.)

Beſides the greater equality in the height of the two ſurfaces, there may ſometimes be other cauſes that retard the farther ſinking of a leaky veſſel. The riſing water within may arrive at quantities of light wooden work, empty cheſts, and particularly empty water caſks, which if fixed ſo as not to float themſelves may help to ſuſtain her. Many bodies which compoſe a ſhip's cargo may be ſpecifically lighter than water, all theſe when out of water are an additional weight to that of the ſhip, and ſhe is in proportion preſſed deeper into the water; but as ſoon as theſe bodies are immerſed, they weigh no longer on the ſhip, but on the contrary, if fixed, they help to ſupport her, in proportion as they are ſpecifically lighter than the water. And it ſhould be remembered, that the largeſt body of a ſhip may be ſo balanced in the water, that an ounce leſs or more of weight may leave her at the ſurface or ſink her to the bottom. There are alſo certain heavy cargoes, that when the water gets at them are continually diſſolving, and thereby lightening the veſſel, ſuch as ſalt and ſugar. And as to water caſks mentioned above, ſince the quantity of them muſt be great in ſhips of war where the number of men conſume a great deal of water every day, if it had been made a conſtant rule to bung them up as faſt as they were emptied, and to diſpoſe the empty caſks in proper ſituations, I am perſuaded that many ſhips which have been ſunk in engagements, or have gone down afterwards, might with the unhappy people have been ſaved; as well as many of thoſe which in the laſt war foundered, and were never heard of. While on this topic of ſinking, one cannot help recollecting the well known practice of the Chineſe, to divide the hold of a great ſhip into a number of ſeparate chambers by partitions tight caulked, (of which you gave a model in your boat upon the Seine) ſo that if a leak ſhould ſpring in one of them

the others are not affected by it; and though that chamber ſhould fill to a level with the ſea, it would not be ſufficient to ſink the veſſel. We have not imitated this practice. Some little diſadvantage it might occaſion in the ſtowage is perhaps one reaſon, though that I think might be more than compenſated by an abatement in the inſurance that would be reaſonable, and by a higher price taken of paſſengers, who would rather prefer going in ſuch a veſſel. But our ſeafaring people are brave, deſpiſe danger, and reject ſuch precautions of ſafety, being cowards only in one ſenſe, that of *fearing* to be *thought afraid*.

I promiſed to finiſh my letter with the laſt obſervation, but the garrulity of the old man has got hold of me, and as I may never have another occaſion of writing on this ſubject, I think I may as well now, once for all, empty my nautical budget, and give you all the thoughts that have in my various long voyages occurred to me relating to navigation. I am ſure that in you they will meet with a candid judge, who will excuſe my miſtakes on account of my good intention.

There are ſix accidents that may occaſion the loſs of ſhips at ſea. We have conſidered one of them, that of foundering by a leak. The other five are, 1. Overſetting by ſudden flaws of wind, or by carrying ſail beyond the bearing. 2. Fire by accident or careleſſneſs. 3. A heavy ſtroke of lightning, making a breach in the ſhip, or firing the powder. 4. Meeting and ſhocking with other ſhips in the night. 5. Meeting in the night with iſlands of ice.

To that of overſetting, privateers in their firſt cruize have, as far as has fallen within my knowledge or information, been more ſubject than any other kind of veſſels. The double deſire of being able to overtake a weaker flying enemy, or to eſcape when purſued by a ſtronger, has induced the owners to overmaſt their cruizers, and to ſpread too much canvas; and the great number of men, many of them

them not ſeamen, who being upon deck when a ſhip heels ſuddenly are huddled down to leeward, and increaſe by their weight the effect of the wind. This therefore ſhould be more attended to and guarded againſt, eſpecially as the advantage of lofty maſts is problematical. For the upper ſails have greater power to lay a veſſel more on her ſide, which is not the moſt advantageous poſition for going ſwiftly through the water. And hence it is that veſſels which have loſt their lofty maſts, and been able to make little more ſail afterwards than permitted the ſhip to ſail upon an even keel, have made ſo much way, even under jury maſts, as to ſurprize the mariners themſelves. But there is beſides, ſomething in the modern form of our ſhips that ſeems as if calculated expreſsly to allow their overſetting more eaſily. The ſides of a ſhip inſtead of ſpreading out as they formerly did in the upper works, are of late years turned in, ſo as to make the body nearly round, and more reſembling a caſk. I do not know what the advantages of this conſtruction are, except that ſuch ſhips are not ſo eaſily boarded. To me it ſeems a contrivance to have leſs room in a ſhip at nearly the ſame expence. For it is evident that the ſame timber and plank conſumed in raiſing the ſides from a to b, and from d to c, would have raiſed them from a to e, and from d to f, fig. 9. In this form all the ſpaces between e, a, b, and c, d, f, would have been gained, the deck would have been larger, the men would have had more room to act, and not have ſtood ſo thick in the way of the enemy's ſhot; and the veſſel the more ſhe was laid down on her ſide, the more bearing ſhe would meet with, and more effectual to ſupport her, as being farther from the center. Whereas in the preſent form, her ballaſt makes the chief part of her bearing, without which ſhe would turn in the ſea almoſt as eaſily as a barrel. More ballaſt by this means becomes neceſſary, and that ſinking a veſſel deeper in the water occaſions more reſiſtance to her going through it. The

Bermudian ſloops ſtill keep with advantage to the old ſpreading form. The iſlanders in the great Pacific ocean, though they have no large ſhips, are the moſt expert boat-ſailors in the world, navigating that ſea ſafely with their proas, which they prevent overſetting by various means. Their ſailing proas for this purpoſe have outriggers generally to windward, above the water, on which one or more men are placed to move occaſionally further from or nearer to the veſſel as the wind freſhens or ſlackens. But ſome have their outriggers to leeward, which reſting on the water ſupport the boat ſo as to keep her upright when preſſed down by the wind. Their boats moved by oars or rather by paddles, are, for long voyages, fixed two together by croſs bars of wood that keep them at ſome diſtance from each other, and ſo render their overſetting next to impoſſible. How far this may be practicable in larger veſſels, we have not yet ſufficient experience. I know of but one trial made in Europe, which was about one hundred years ſince by, Sir William Petty. He built a double veſſel, to ſerve as a pacquet boat between England and Ireland. Her model ſtill exiſts in the muſeum of the Royal Society, where I have ſeen it. By the accounts we have of her, ſhe anſwered well the purpoſe of her conſtruction, making ſeveral voyages; and though wrecked at laſt by a ſtorm, the misfortune did not appear owing to her particular conſtruction, ſince many other veſſels of the common form were wrecked at the ſame time. The advantage of ſuch a veſſel is: That ſhe needs no ballaſt, therefore ſwims either lighter or will carry more goods; and that paſſengers are not ſo much incommoded by her rolling: to which may be added, that if ſhe is to defend herſelf by her cannon, they will probably have more effect, being kept more generally in a horizontal poſition, than thoſe in common veſſels. I think however that it would be an improvement of that model, to make the ſides

which

which are oppofed to each other perfectly parallel, though the other fides are formed as in common thus, figure 10.

The building of a double fhip would indeed be more expenfive in proportion to her burthen; and that perhaps is fufficient to difcourage the method.

The accident of fire is generally well guarded againft by the prudent captain's ftrict orders againft fmoking between decks, or carrying a candle there out of a lanthorn. But there is one dangerous practice which frequent terrible accidents have not yet been fufficient to abolifh; that of carrying ftore-fpirits to fea in cafks. Two large fhips, the Seraphis and the Duke of Athol, one an Eaft-Indiaman, the other a frigate, have been burnt within thefe two laft years, and many lives miferably deftroyed, by drawing fpirits out of a cafk near a candle. It is high time to make it a general rule, that all the fhip's ftore of fpirits fhould be carried in bottles.

The misfortune by a ftroke of lightning I have in my former writings endeavoured to fhow a method of guarding againft, by a chain and pointed rod, extending, when run up, from above the top of the maft to the fea. Thefe inftruments are now made and fold at a reafonable price by *Nairne and Co.* in London, and there are feveral inftances of fuccefs attending the ufe of them. They are kept in a box, and may be run up and fixed in about five minutes, on the apparent approach of a thunder guft.

Of the meeting and fhocking with other fhips in the night, I have known two inftances in voyages between London and America. In one both fhips arrived though much damaged, each reporting their belief that the other muft have gone to the bottom. In the other, only one got to port; the other was never afterwards heard of. Thefe inftances happened many years ago, when the commerce between Europe and America was not a tenth part of what it is at prefent, fhips of courfe thinner fcattered, and the chance of meeting proportionably lefs. It has long

been

been the practice to keep a *look-out before* in the channel, but at ſea it has been neglected. If it is not at preſent thought worth while to take that precaution, it will in time become of more conſequence; ſince the number of ſhips at ſea is continually augmenting. A drum frequently beat or a bell rung in a dark night, might help to prevent ſuch accidents.

Iſlands of ice are frequently ſeen off the banks of Newfoundland, by ſhips going between North-America and Europe. In the day-time they are eaſily avoided, unleſs in a very thick fog. I remember two inſtances of ſhips running againſt them in the night. The firſt loſt her bowſprit, but received little other damage. The other ſtruck where the warmth of the ſea had waſted the ice next to it, and a part hung over above. This perhaps ſaved her, for ſhe was under great way; but the upper part of the cliff taking her foretopmaſt, broke the ſhock, though it carried away the maſt. She diſengaged herſelf with ſome difficulty, and got ſafe into port; but the accident ſhows the poſſibility of other ſhips being wrecked and ſunk by ſtriking thoſe vaſt maſſes of ice, of which I have ſeen one that we judged to be ſeventy feet high above the water, conſequently eight times as much under water; and it is another reaſon for keeping a good *look-out before*, though far from any coaſt that may threaten danger.

It is remarkable that the people we conſider as ſavages, have improved the art of ſailing- and rowing-boats in ſeveral points beyond what we can pretend to. We have no ſailing boats equal to the flying proas of the ſouth ſeas, no rowing or paddling boat equal to that of the Greenlanders for ſwiftneſs and ſafety. The birch canoes of the North-American Indians have alſo ſome advantageous properties. They are ſo light that two men may carry one of them over land, which is capable of carrying a dozen upon the water; and in heeling they are not ſo ſubject to take in water as our boats, the ſides of which are

loweſt

loweſt in the middle where it is moſt likely to enter, this being higheſt in that part, as in figure 11.

The Chineſe are an enlightened people, the moſt antiently civilized of any exiſting, and their arts are antient, a preſumption in their favour: their method of rowing their boats differs from ours, the oars being worked either two a-ſtern as we ſcull, or on the ſides with the ſame kind of motion, being hung parallel to the keel on a rail and always acting in the water, not perpendicular to the ſide as ours are, nor lifted out at every ſtroke, which is a loſs of time, and the boat in the interval loſes motion. They ſee our manner, and we theirs, but neither are diſpoſed to learn of or copy the other.

To the ſeveral means of moving boats mentioned above, may be added the ſingular one lately exhibited at Javelle, on the Seine below Paris, where a clumſy boat was moved acroſs that river in three minutes by rowing, not in the water, but in the air, that is, by whirling round a ſet of windmill vanes fixed to a horizontal axis, parallel to the keel, and placed at the head of the boat. The axis was bent into an elbow at the end, by the help of which it was turned by one man at a time. I ſaw the operation at a diſtance. The four vanes appeared to be about five feet long, and perhaps two and a half wide. The weather was calm. The labour appeared to be great for one man, as the two ſeveral times relieved each other. But the action upon the air by the oblique ſurfaces of the vanes muſt have been conſiderable, as the motion of the boat appeared tolerably quick going and returning; and ſhe returned to the ſame place from whence ſhe firſt ſet out, notwithſtanding the current. This machine is ſince applied to the moving of air balloons: An inſtrument ſimilar may be contrived to move a boat by turning under water.

Several mechanical projectors have at different times propoſed to give motion to boats, and even to ſhips, by means of circular rowing, or paddles placed on the circum-

ference

ference of wheels to be turned conſtantly on each ſide of the veſſel; but this method, though frequently tried, has never been found ſo effectual as to encourage a continuance of the practice. I do not know that the reaſon has hitherto been given. Perhaps it may be this, that great part of the force employed contributes little to the motion. For inſtance, (fig. 12.) of the four paddles a, b, c, d, all under water, and turning to move a boat from X to Y, c has the moſt power, b nearly though not quite as much, their motion being nearly horizontal; but the force employed in moving a, is conſumed in preſſing almoſt downright upon the water till it comes to the place of b; and the force employed in moving d is conſumed in lifting the water till d arrives at the ſurface; by which means much of the labour is loſt. It is true, that by placing the wheels higher out of the water, this waſte labour will be diminiſhed in a calm, but where a ſea runs, the wheels muſt unavoidably be often dipt deep in the waves, and the turning of them thereby rendered very laborious to little purpoſe.

Among the various means of giving motion to a boat, that of M. Bernoulli appears one of the moſt ſingular, which was to have fixed in the boat a tube in the form of an L, the upright part to have a funnel-kind of opening at top, convenient for filling the tube with water; which deſcending and paſſing through the lower horizontal part, and iſſuing in the middle of the ſtern, but under the ſurface of the river, ſhould puſh the boat forward. There is no doubt that the force of the deſcending water would have a conſiderable effect, greater in proportion to the height from which it deſcended; but then it is to be conſidered, that every bucket-full pumped or dipped up into the boat, from its ſide or through its bottom, muſt have its *vis inertiæ* overcome ſo as to receive the motion of the boat, before it can come to give motion by its deſcent; and that will be a deduction from the moving power.

To

To remedy this, I would propoſe the addition of another ſuch L pipe, and that they ſhould ſtand back to back in the boat thus, figure 13. the forward one being worked as a pump, and ſucking in the water at the head of the boat, would draw it forward while puſhed in the ſame direction by the force at the ſtern. And after all it ſhould be calculated whether the labour of pumping would be leſs than that of rowing. A fire-engine might poſſibly in ſome caſes be applied in this operation with advantage.

Perhaps this labour of raiſing water might be ſpared, and the whole force of a man applied to the moving of a boat by the uſe of air inſtead of water; ſuppoſe the boat conſtructed in this form, figure 14. A, a tube round or ſquare of two feet diameter, in which a piſton may move up and down. The piſton to have valves in it, opening inwards to admit air when the piſton riſes; and ſhutting, when it is forced down by means of the lever B turning on the center C. The tube to have a valve D, to open when the piſton is forced down, and let the air paſs out at E, which ſtriking forcibly againſt the water abaft muſt puſh the boat forward. If there is added an air-veſſel F properly valved and placed, the force would continue to act while a freſh ſtroke is taken with the lever. The boatman might ſtand with his back to the ſtern, and putting his hands behind him, work the motion by taking hold of the croſs bar at B, while another ſhould ſteer; or if he had two ſuch pumps, one on each ſide of the ſtern, with a lever for each hand, he might ſteer himſelf by working occaſionally more or harder with either hand, as watermen now do with a pair of ſculls. There is no poſition in which the body of a man can exert more ſtrength than in pulling right upwards.

To obtain more ſwiftneſs, greaſing the bottom of a veſſel is ſometimes uſed, and with good effect. I do not know that any writer has hitherto attempted to explain this. At firſt ſight one would imagine, that though the friction of a hard body ſliding on another hard body, and

 the

the refiftance occafioned by that friction, might be diminifhed by putting greafe between them, yet that a body fliding on a fluid, fuch as water, fhould have no need of nor receive any advantage from fuch greafing. But the fact is not difputed. And the reafon perhaps may be this. The particles of water have a mutual attraction, called the attraction of adhefion. Water alfo adheres to wood, and to many other fubftances, but not to greafe: On the contrary they have a mutual repulfion, fo that it is a queftion whether when oil is poured on water, they ever actually touch each other; for a drop of oil upon water, inftead of fticking to the fpot where it falls, as it would if it fell on a looking-glafs, fpreads inftantly to an immenfe diftance in a film extremely thin, which it could not eafily do if it touched and rubbed or adhered even in a fmall degree to the furface of the water. Now the adhefive force of water to itfelf, and to other fubftances, may be eftimated from the weight of it neceffary to feparate a drop, which adheres, while growing, till it has weight enough to force the feparation and break the drop off. Let us fuppofe the drop to be the fize of a pea, then there will be as many of thefe adhefions as there are drops of that fize touching the bottom of a veffel, and thefe muft be broken by the moving power, every ftep of her motion that amounts to a drop's breadth: And there being no fuch adhefions to break between the water and a greafed bottom, may occafion the difference.

So much refpecting the motion of veffels. But we have fometimes occafion to ftop their motion; and if a bottom is near enough we can caft anchor: Where there are no foundings, we have as yet no means to prevent driving in a ftorm, but by lying-to, which ftill permits driving at the rate of about two miles an hour; fo that in a ftorm continuing fifty hours, which is not an uncommon cafe, the fhip may drive one hundred miles out of her courfe; and fhould fhe in that diftance meet with a lee fhore, fhe may be loft.

To

To prevent this driving to leeward in deep water, a ſwimming anchor is wanting, which ought to have theſe properties.

1. It ſhould have a ſurface ſo large as being at the end of a hauſer in the water, and placed perpendicularly, ſhould hold ſo much of it, as to bring the ſhip's head to the wind, in which ſituation the wind has leaſt power to drive her.

2. It ſhould be able by its reſiſtance to prevent the ſhip's receiving way.

3. It ſhould be capable of being ſituated below the heave of the ſea, but not below the undertow.

4. It ſhould not take up much room in the ſhip.

5. It ſhould be eaſily thrown out, and put into its proper ſituation.

6. It ſhould be eaſy to take in again, and ſtow away.

An ingenious old mariner whom I formerly knew, propoſed as a ſwimming anchor for a large ſhip to have a ſtem of wood twenty-five feet long and four inches ſquare, with four boards of 18, 16, 14, and 12, feet long, and one foot wide, the boards to have their ſubſtance thickened ſeveral inches in the middle by additional wood, and to have each a four inch ſquare hole through its middle, to permit its being ſlipt on occaſionally upon the ſtem, and at right angles with it; where all being placed and fixed at four feet diſtance from each other, it would have the appearance of the old mathematical inſtrument called a foreſtaff. This thrown into the ſea, and held by a hauſer veered out to ſome length, he conceived would bring a veſſel up, and prevent her driving, and when taken in might be ſtowed away by ſeparating the boards from the ſtem. Figure 15. Probably ſuch a ſwimming anchor would have ſome good effect, but it is ſubject to this objection, that lying on the ſurface of the ſea, it is liable to be hove forward by every wave, and thereby give ſo much leave for the ſhip to drive.

Two machines for this purpofe have occurred to me, which though not fo fimple as the above, I imagine would be more effectual, and more eafily manageable. I will endeavour to defcribe them, that they may be fubmitted to your judgment, whether either would be ferviceable; and if they would, to which we fhould give the preference.

The firft is to be formed, and to be ufed in the water on almoft the fame principles with thofe of a paper kite ufed in the air. Only as the paper kite rifes in the air, this is to defcend in the water. Its dimenfions will be different for fhips of different fize.

To make one of fuppofe fifteen feet high; take a fmall fpar of that length for the back-bone, AB, figure 16, a fmaller of half that length CD, for the crofs piece. Let thefe be united by a bolt at E, yet fo as that by turning on the bolt they may be laid parallel to each other. Then make a fail of ftrong canvas, in the fhape of figure 17. To form this, without wafte of fail-cloth, few together pieces of the proper length, and for half the breadth, as in figure 18, then cut the whole in the diagonal lines a, b, c, and turn the piece F fo as to place its broad part oppofite to that of the piece G, and the piece H in like manner oppofite to I, which when all fewed together will appear as in figure 17. This fail is to be extended on the crofs of figure 16, the top and bottom points well fecured to the ends of the long fpar; the two fide points d, e, faftened to the ends of two cords, which coming from the angle of the loop (which muft be fimilar to the loop of a kite) pafs through two rings at the ends of the fhort fpar, fo as that on pulling upon the loop the fail will be drawn to its extent. The whole may, when aboard, be furled up, as in figure 19, having a rope from its broad end, to which is tied a bag of ballaft for keeping that end downwards when in the water, and at the other end another rope with an empty keg at its end to float on the furface; this

R E M A R K S

Upon the Navigation from

NEWFOUNDLAND TO NEW-YORK,

In order to avoid the

GULPH STREAM

On one hand, and on the other the SHOALS *that lie to the Southward of Nantucket and of St. George's Banks.*

AFTER you have paſſed the Banks of Newfoundland in about the 44th degree of latitude, you will meet with nothing, till you draw near the Iſle of Sables, which we commonly paſs in latitude 43. Southward of this iſle, the current is found to extend itſelf as far North as 41° 20′ or 30′, then it turns towards the E. S. E. or S. E. $\frac{1}{4}$ E.

Having paſſed the Iſle of Sables, ſhape your courſe for the St. George's Banks, ſo as to paſs them in about latitude 40°, becauſe the current ſouthward of thoſe banks reaches as far North as 39° The ſhoals of thoſe banks lie in 41° 35′.

After having paſſed St. George's Banks, you muſt, to clear Nantucket, form your courſe ſo as to paſs between the latitudes 38° 30′ and 40° 45′.

The moſt ſouthern part of the ſhoals of Nantucket lie in about 40° 45′. The northern part of the current directly to the ſouth of Nantucket is felt in about latitude 38° 30′.

By obſerving theſe directions and keeping between the ſtream and the ſhoals, the paſſage from the Banks of Newfoundland to New-York, Delaware, or Virginia, may be conſiderably ſhortened; for ſo you will have the advantage of the eddy current, which moves contrary to the Gulph Stream. Whereas if to avoid the ſhoals you keep too far to the ſouthward, and get into that ſtream, you will be retarded by it at the rate of 60 or 70 miles a day.

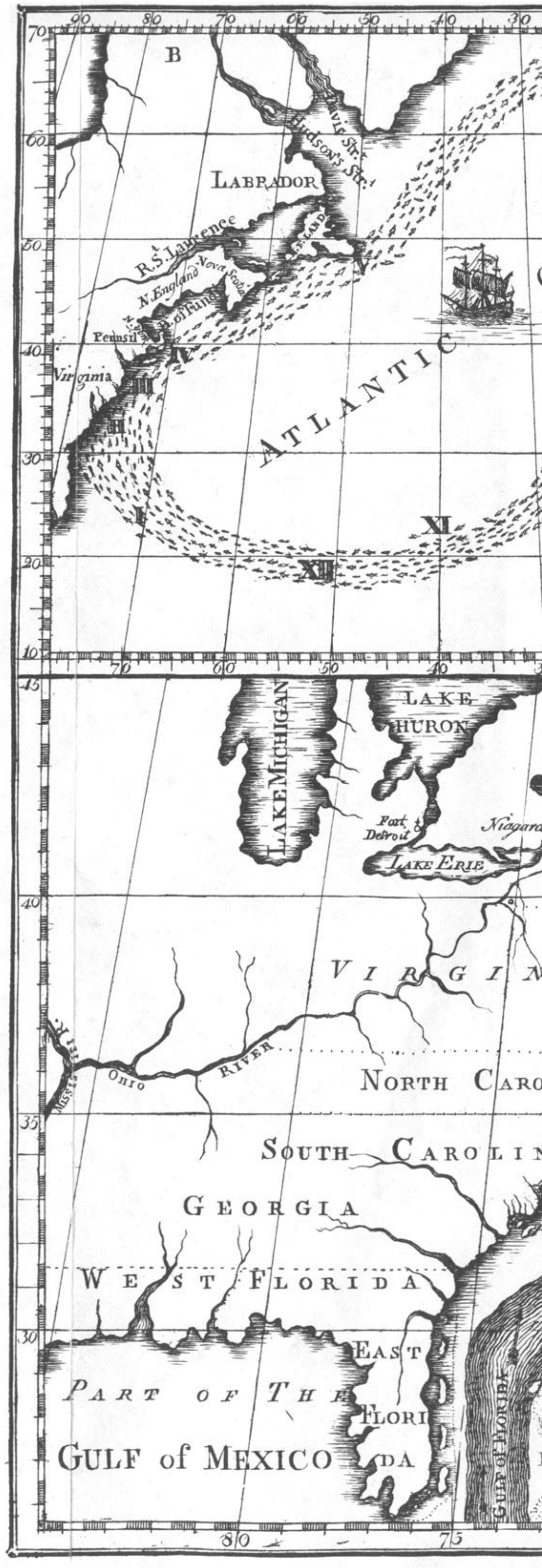
The Nantucket whale-men being extremely well acquainted with the Gulph Stream, its courſe, ſtrength and extent, by their conſtant practice of whaling on the edges of it, from their iſland quite down to the Bahamas, this draft of that ſtream was obtained from one of them, Capt. Folger, and cauſed to be engraved on the old chart in London, for the benefit of navigators, by

B. FRANKLIN.

Note, The Nantucket captains who are acquainted with this ſtream, make their voyages from England to Boſton in as ſhort a time generally as others take in going from Boſton to England, viz. from 20 to 30 days.

A ſtranger may know when he is in the Gulph Stream, by the warmth of the water, which is much greater than that of the water on each ſide of it. If then he is bound to the weſtward, he ſhould croſs the ſtream to get out of it as ſoon as poſſible.

B. F.



facing page 315.

facing page 315.

this rope long enough to permit the kite's defcending into the undertow, or if you pleafe lower into ftill water. It fhould be held by a haufer. To get it home eafily, a fmall loofe rope may be veered out with it, fixed to the keg. Hauling on that rope will bring the kite home with fmall force, the refiftance being fmall as it will then come endways.

It feems probable that fuch a kite at the end of a long haufer would keep a fhip with her head to the wind, and refifting every tug, would prevent her driving fo faft as when her fide is expofed to it, and nothing to hold her back. If only half the driving is prevented, fo as that fhe moves but fifty miles inftead of the hundred during a ftorm, it may be fome advantage, both in holding fo much diftance as is faved, and in keeping from a lee fhore. If fingle canvas fhould not be found ftrong enough to bear the tug without fplitting, it may be doubled, or ftrengthened by a netting behind it, reprefented by figure 20.

The other machine for the fame purpofe, is to be made more in the form of an umbrella, as reprefented, figure 21. The ftem of the umbrella a fquare fpar of proper length, with four moveable arms, of which two are reprefented C, C, figure 22. Thefe arms to be fixed in four joint cleats, as D, D, &c. one on each fide of the fpar, but fo as that the four arms may open by turning on a pin in the joint. When open they form a crofs, on which a four fquare canvas fail is to be extended, its corners faftened to the ends of the four arms. Thofe ends are alfo to be ftayed by ropes faftened to the ftem or fpar, fo as to keep them fhort of being at right angles with it: And to the end of one of the arms fhould be hung the fmall bag of ballaft, and to the end of the oppofite arm the empty keg. This on being thrown into the fea, would immediately open; and when it had performed its function, and the ftorm over, a fmall rope from its other end being pulled on, would turn it, clofe it, and draw it eafily home to the fhip. This machine feems more fimple in its operation,

ration, and more eaſily manageable than the firſt, and perhaps may be as effectual.*

Veſſels are ſometimes retarded, and ſometimes forwarded in their voyages, by currents at ſea, which are often not perceived. About the year 1769 or 70, there was an application made by the board of cuſtoms at Boſton, to the lords of the treaſury in London, complaining that the packets between Falmouth and New-York, were generally a fortnight longer in their paſſages, than merchant ſhips from London to Rhode-Iſland, and propoſing that for the future they ſhould be ordered to Rhode-Iſland inſtead of New-York. Being then concerned in the management of the American poſt-office, I happened to be conſulted on the occaſion; and it appearing ſtrange to me that there ſhould be ſuch a difference between two places, ſcarce a day's run aſunder, eſpecially when the merchant ſhips are generally deeper laden, and more weakly manned than the packets, and had from London the whole length of the river and channel to run before they left the land of England, while the packets had only to go from Falmouth, I could not but think the fact miſunderſtood or miſrepreſented. There happened then to be in London, a Nantucket ſea-captain of my acquaintance, to whom I communicated the affair. He told me he believed the fact might be true; but the difference was owing to this, that the Rhode-Iſland captains were acquainted with the gulf ſtream, which thoſe of the Engliſh packets were not. We are well acquainted with that ſtream, ſays he, becauſe in our purſuit of whales, which keep near the ſides of it, but are not to be met with in it, we run down along the ſides, and frequently croſs it to change our ſide: and in croſſing it have ſometimes met and ſpoke with thoſe packets, who were in the middle of it, and ſtemming it. We have informed them that they were

* Captain Truxton, on board whoſe ſhip this was written, has executed this propoſed machine; he has given ſix arms to the umbrella, they are joined to the ſtem by iron hinges, and the canvas is double. He has taken it with him to China. February 1786.

were ſtemming a current, that was againſt them to the value of three miles an hour; and adviſed them to croſs it and get out of it; but they were too wiſe to be counſelled by ſimple American fiſhermen. When the winds are but light, he added, they are carried back by the current more than they are forwarded by the wind: and if the wind be good, the ſubtraction of 70 miles a day from their courſe is of ſome importance. I then obſerved that it was a pity no notice was taken of this current upon the charts, and requeſted him to mark it out for me, which he readily complied with, adding directions for avoiding it in ſailing from Europe to North-America. I procured it to be engraved by order from the general poſt-office, on the old chart of the Atlantic, at Mount and Page's, Tower-hill; and copies were ſent down to Falmouth for the captains of the packets, who ſlighted it however; but it is ſince printed in France, of which edition I hereto annex a copy.

This ſtream is probably generated by the great accumulation of water on the eaſtern coaſt of America between the tropics, by the trade winds which conſtantly blow there. It is known that a large piece of water ten miles broad and generally only three feet deep, has by a ſtrong wind had its waters driven to one ſide and ſuſtained ſo as to become ſix feet deep, while the windward ſide was laid dry. This may give ſome idea of the quantity heaped up on the American coaſt, and the reaſon of its running down in a ſtrong current through the iſlands into the bay of Mexico, and from thence iſſuing through the gulph of Florida, and proceeding along the coaſt to the banks of Newfoundland, where it turns off towards and runs down through the Weſtern iſlands. Having ſince croſſed this ſtream ſeveral times in paſſing between America and Europe, I have been attentive to ſundry circumſtances relating to it, by which to know when one is in it; and beſides the gulph weed with which it is interſperſed, I find that

that it is always warmer than the ſea on each ſide of it, and that it does not ſparkle in the night: I annex hereto the obſervations made with the thermometer in two voyages, and poſſibly may add a third. It will appear from them, that the thermometer may be an uſeful inſtrument to a navigator, ſince currents coming from the northward into ſouthern ſeas, will probably be found colder than the water of thoſe ſeas, as the currents from ſouthern ſeas into northern are found warmer. And it is not to be wondered that ſo vaſt a body of deep warm water, ſeveral leagues wide, coming from between the tropics and iſſuing out of the gulph into the northern ſeas, ſhould retain its warmth longer than the twenty or thirty days required to its paſſing the banks of Newfoundland. The quantity is too great, and it is too deep to be ſuddenly cooled by paſſing under a cooler air. The air immediately over it, however, may receive ſo much warmth from it as to be rarified and riſe, being rendered lighter than the air on each ſide of the ſtream; hence thoſe airs muſt flow in to ſupply the place of the riſing warm air, and meeting with each other, form thoſe tornados and water-ſpouts frequently met with, and ſeen near and over the ſtream; and as the vapour from a cup of tea in a warm room, and the breath of an animal in the ſame room, are hardly viſible, but become ſenſible immediately when out in the cold air, ſo the vapour from the gulph ſtream, in warm latitudes is ſcarcely viſible, but when it comes into the cool air from Newfoundland, it is condenſed into the fogs, for which thoſe parts are ſo remarkable.

The power of wind to raiſe water above its common level in the ſea, is known to us in America, by the high tides occaſioned in all our ſea-ports when a ſtrong northeaſter blows againſt the gulph ſtream.

The concluſion from theſe remarks is, that a veſſel from Europe to North-America may ſhorten her paſſage by avoiding to ſtem the ſtream, in which the thermometer will be

be very ufeful; and a veffel from America to Europe may do the fame by the fame means of keeping in it. It may have often happened accidentally, that voyages have been fhortened by thefe circumftances. It is well to have the command of them.

But may there not be another caufe, independent of winds and currents, why paffages are generally fhorter from America to Europe than from Europe to America? This queftion I formerly confidered in the following fhort paper.

On board the Pennfylvania Packet, Capt. Ofborne,
At fea, April 5, 1775.

"Suppofe a fhip to make a voyage eaftward from a place in lat. 40° north, to a place in lat. 50° north, diftance in longitude 75 degrees.

"In failing from 40 to 50, fhe goes from a place where a degree of longitude is about eight miles greater than in the place fhe is going to. A degree is equal to four minutes of time; confequently the fhip in the harbour fhe leaves, partaking of the diurnal motion of the earth, moves two miles in a minute fafter, than when in the port fhe is going to; which is 120 miles in an hour.

"This motion in a fhip and cargo is of great force; and if fhe could be lifted up fuddenly from the harbour in which fhe lay quiet, and fet down inftantly in the latitude of the port fhe was bound to, though in a calm, that force contained in her would make her run a great way at a prodigious rate. This force muft be loft gradually in her voyage, by gradual impulfe againft the water, and probably thence fhorten the voyage. Query, In returning does the contrary happen, and is her voyage thereby retarded and lengthened?" *

Would it not be a more fecure method of planking fhips, if inftead of thick fingle planks laid horizontally, we were

* Since this paper was read at the Society, an ingenious member, Mr. Patterfon, has convinced the writer that the returning voyage would not, from this caufe, be retarded.

to uſe planks of half the thickneſs, and lay them double and acroſs each other as in figure 23? To me it ſeems that the difference of expence would not be conſiderable, and that the ſhip would be both tighter and ſtronger.

The ſecuring of the ſhip is not the only neceſſary thing; ſecuring the health of the ſailors, a brave and valuable order of men, is likewiſe of great importance. With this view the methods ſo ſucceſsfully practiſed by Captain Cook in his long voyages, cannot be too cloſely ſtudied or carefully imitated. A full account of thoſe methods is found in Sir John Pringle's ſpeech, when the medal of the Royal Society was given to that illuſtrious navigator. I am glad to ſee in his laſt voyage that he found the means effectual which I had propoſed for preſerving flour, bread, &c. from moiſture and damage. They were found dry and good after being at ſea four years. The method is deſcribed in my printed works, page 452, fifth edition. In the ſame, page 469, 470, is propoſed a means of allaying thirſt in caſe of want of freſh water. This has ſince been practiſed in two inſtances with ſucceſs. Happy if their hunger, when the other proviſions are conſumed, could be relieved as commodiouſly; and perhaps in time this may be found not impoſſible. An addition might be made to their preſent vegetable proviſion, by drying various roots in ſlices by the means of an oven. The ſweet potatoe of America and Spain, is excellent for this purpoſe. Other potatoes, with carrots, parſnips and turnips, might be prepared and preſerved in the ſame manner.

With regard to make-ſhifts in caſes of neceſſity, ſeamen are generally very ingenious themſelves. They will excuſe however the mention of two or three. If they happen in any circumſtance, ſuch as after ſhipwreck, taking to their boat, or the like, to want a compaſs, a fine ſewing-needle laid on clear water in a cup will generally point to the north, moſt of them being a little magnetical, or may be made ſo by being ſtrongly rubbed or hammered,

ed, lying in a north and ſouth direction. If their needle is too heavy to float by itſelf, it may be ſupported by little pieces of cork or wood. A man who can ſwim, may be aided in a long traverſe by his handkerchief formed into a kite, by two croſs ſticks extending to the four corners; which being raiſed in the air, when the wind is fair and freſh, will tow him along while lying on his back. Where force is wanted to move a heavy body, and there are but few hands and no machines, a long and ſtrong rope may make a powerful inſtrument. Suppoſe a boat is to be drawn up on a beach, that ſhe may be out of the ſurf, a ſtake drove into the beach where you would have the boat drawn; and another to faſten the end of the rope to, which comes from the boat, and then applying what force you have to pull upon the middle of the rope at right angles with it, the power will be augmented in proportion to the length of rope between the poſts. The rope being faſtened to the ſtake A, and drawn upon in the direction C D, will ſlide over the ſtake B; and when the rope is bent to the angle A D B, repreſented by the pricked line in figure 24, the boat will be at B.

Some ſailors may think the writer has given himſelf unneceſſary trouble in pretending to adviſe them; for they have a little repugnance to the advice of landmen, whom they eſteem ignorant and incapable of giving any worth notice; though it is certain that moſt of their inſtruments were the invention of landmen. At leaſt the firſt veſſel ever made to go on the water was certainly ſuch. I will therefore add only a few words more, and they ſhall be addreſſed to paſſengers.

When you intend a long voyage, you may do well to keep your intention as much as poſſible a ſecret, or at leaſt the time of your departure; otherwiſe you will be continually interrupted in your preparations by the viſits of friends and acquaintance, who will not only rob you of the time you want, but put things out of your mind, ſo

that when you come to ſea, you have the mortification to recollect points of buſineſs that ought to have been done, accounts you had intended to ſettle, and conveniencies you had propoſed to bring with you, &c. &c. all which have been omitted through the effect of theſe officious friendly viſits. Would it not be well if this cuſtom could be changed; if the voyager after having, without interruption, made all his preparations, ſhould uſe ſome of the time he has left, in going himſelf to take leave of his friends at their own houſes, and let them come to congratulate him on his happy return.

It is not always in your power to make a choice in your captain, though much of your comfort in the paſſage may depend on his perſonal character, as you muſt for ſo long a time be confined to his company, and under his direction; if he be a ſenſible, ſociable, good natured, obliging man, you will be ſo much the happier. Such there are; but if he happens to be otherwiſe, and is only ſkilful, careful, watchful and active in the conduct of his ſhip, excuſe the reſt, for theſe are the eſſentials.

Whatever right you may have by agreement in the maſs of ſtores laid in by him for the paſſengers, it is good to have ſome particular things in your own poſſeſſion, ſo as to be always at your own command.

1. Good water, that of the ſhip being often bad. You can be ſure of having it good only by bottling it from a clear ſpring or well and in clean bottles. 2. Good tea. 3. Coffee ground. 4. Chocolate. 5. Wine of the ſort you particularly like, and cyder. 6. Raiſins. 7. Almonds 8. Sugar. 9. Capillaire. 10. Lemons. 11. Jamaica ſpirits. 12. Eggs greas'd. 13. Diet bread. 14. Portable ſoup. 15. Ruſks. As to fowls, it is not worth while to have any called yours, unleſs you could have the feeding and managing of them according to your own judgment under your own eye. As they are generally treated at preſent in ſhips, they are for the moſt part ſick, and their fleſh tough

tough and hard as whitleather. All ſeamen have an opinion, broached I ſuppoſed at firſt prudently, for ſaving of water when ſhort, that fowls do not know when they have drank enough, and will kill themſelves if you give them too much, ſo they are ſerved with a little only once in two days. This is poured into troughs that lie ſloping, and therefore immediately runs down to the lower end. There the fowls ride upon one another's backs to get at it, and ſome are not happy enough to reach and once dip their bills in it. Thus tantalized, and tormented with thirſt, they cannot digeſt their dry food, they fret, pine, ſicken and die. Some are found dead, and thrown overboard every morning, and thoſe killed for the table are not eatable. Their troughs ſhould be in little diviſions like cups to hold the water ſeparately, figure 25. But this is never done. The ſheep and hogs are therefore your beſt dependance for freſh meat at ſea, the mutton being generally tolerable and the pork excellent.

It is poſſible your captain may have provided ſo well in the general ſtores, as to render ſome of the particulars above recommended of little or no uſe to you. But there are frequently in the ſhip poorer paſſengers, who are taken at a lower price, lodge in the ſteerage, and have no claim to any of the cabbin proviſions, or to any but thoſe kinds that are allowed the ſailors. Theſe people are ſometimes dejected, ſometimes ſick, there may be women and children among them. In a ſituation where there is no going to market, to purchaſe ſuch neceſſaries, a few of theſe your ſuperfluities diſtributed occaſionally may be of great ſervice, reſtore health, ſave life, make the miſerable happy, and thereby afford you infinite pleaſure.

The worſt thing in ordinary merchant ſhips is the cookery. They have no profeſſed cook, and the worſt hand as a ſeaman is appointed to that office, in which he is not only very ignorant but very dirty. The ſailors have

have therefore a ſaying, that *God ſends meat and the devil cooks.* Paſſengers more piouſly diſpoſed, and willing to believe heaven orders all things for the beſt, may ſuppoſe that knowing the ſea-air and conſtant exerciſe by the motion of the veſſel would give us extraordinary appetites, bad cooks were kindly ſent to prevent our eating too much; or, that foreſeeing we ſhould have bad cooks, good appetites were furniſhed to prevent our ſtarving. If you cannot truſt to theſe circumſtances, a ſpirit-lamp, with a blaze-pan, may enable you to cook ſome little things for yourſelf; ſuch as a haſh, a ſoup, &c. And it might be well alſo to have among your ſtores ſome potted meats, which if well put up will keep long good. A ſmall tin-oven to place with the open ſide before the fire, may be another good utenſil, in which your own ſervant may roaſt for you a bit of pork or mutton. You will ſometimes be induced to eat of the ſhip's ſalt beef, as it is often good. You will find cyder the beſt quencher of that thirſt which ſalt meat or fiſh occaſions. The ſhip biſcuit is too hard for ſome ſets of teeth. It may be ſoftened by toaſting. But ruſk is better; for being made of good fermented bread, ſliced and baked a ſecond time, the pieces imbibe the water eaſily, ſoften immediately, digeſt more kindly and are therefore more wholſome than the unfermented biſcuit. By the way, ruſk is the true original biſcuit, ſo prepared to keep for ſea, biſcuit in French ſignifying twice baked. If your dry peas boil hard, a two-pound iron ſhot put with them into the pot, will by the motion of the ſhip grind them as fine as muſtard.

The accidents I have ſeen at ſea with large diſhes of ſoup upon a table, from the motion of the ſhip, have made me wiſh that our potters or pewterers would make ſoup-diſhes in diviſions, like a ſet of ſmall bowls united together, each containing about ſufficient for one perſon, in ſome ſuch form as fig. 26; for then when the ſhip ſhould make a ſudden heel, the ſoup would not in a body flow

over

over one ſide, and fall into people's laps and ſcald them, as is ſometimes the caſe, but would be retained in the ſeparate diviſions, as in figure 27.

After theſe trifles, permit the addition of a few general reflections. Navigation when employed in ſupplying neceſſary proviſions to a country in want, and thereby preventing famines, which were more frequent and deſtructive before the invention of that art, is undoubtedly a bleſſing to mankind. When employed merely in tranſporting ſuperfluities, it is a queſtion whether the advantage of the employment it affords is equal to the miſchief of hazarding ſo many lives on the ocean. But when employed in pillaging merchants and tranſporting ſlaves, it is clearly the means of augmenting the maſs of human miſery. It is amazing to think of the ſhips and lives riſqued in fetching tea from China, coffee from Arabia, ſugar and tobacco from America, all which our anceſtors did well without. Sugar employs near one thouſand ſhips, tobacco almoſt as many. For the utility of tobacco there is little to be ſaid; and for that of ſugar, how much more commendable would it be if we could give up the few minutes gratification afforded once or twice a day by the taſte of ſugar in our tea, rather than encourage the cruelties exerciſed in producing it. An eminent French moraliſt ſays, that when he conſiders the wars we excite in Africa to obtain ſlaves, the numbers neceſſarily ſlain in thoſe wars, the many priſoners who periſh at ſea by ſickneſs, bad proviſions, foul air, &c. &c. in the tranſportation, and how many afterwards die from the hardſhips of ſlavery, he cannot look on a piece of ſugar without conceiving it ſtained with ſpots of human blood! Had he added the conſideration of the wars we make to take and retake the ſugar iſlands from one another, and the fleets and armies that periſh in thoſe expeditions, he might have ſeen his ſugar not merely ſpotted, but thoroughly dyed ſcarlet in grain. It is theſe wars that make the maritime powers of Europe, the

the inhabitants of London and Paris, pay dearer for ſugar than thoſe of Vienna, a thouſand miles from the ſea ; becauſe their ſugar coſts not only the price they pay for it by the pound, but all they pay in taxes to maintain the fleets and armies that fight for it.

With great eſteem, I am, Sir,

Your moſt obedient humble ſervant,

B. FRANKLIN.

Obſervations

Obſervations of the warmth of the ſea-water, &c. by Fahrenheit's thermometer, in croſſing the Gulph ſtream; with other remarks made on board the Pennſylvania packet, Capt. Oſborne, bound from London to Philadelphia, in April and May 1775.

Date.	Hour.	Temp. of Air.	Temp. of Wat.	Wind.	Courſe.	Diſtance.	Latitude N.	Longitude W.	Remarks.
April 10			62						
11			61						
12			64						
13			65						
							° '	° '	
14			65						
26		60	70				37 39	60 38	Much gulph weed; ſaw a whale.
27		60	70	S S E	W b S		37 13	62 29	Colour of water changed.
28	8A.M.	70	64	S W	W N W		37 48	64 35	No gulph weed.
—	6 P.M.	67	60			34			Sounded, no bottom.
29	8A.M.	63	71	N	W	44	37 26	66 0	Much light in the water laſt nig.
—	5 P.M.	65	72	N E		57			Water again of the uſual deep ſea
—	11 dit.	66	66	N WbN	W b S				colour, little or no light in it at
30	8A.M.	64	70	N E	W b N	69			night.
—	12	62	70		E b S	24	37 20	68 53	Frequent gulph weed, water con-
—	6 P.M.	64	72	E S E	W b N	43			tinues of ſea colour, little light.
—	10 dit.	65	65	S		25			Much light.
May 1	7A.M.	68	63			60			Much light all laſt night.
—	12	65	56	S S W	W N W	44	38 13	72 23	Colour of water changed.
—	4 P.M.	64	56		W b N	21			
—	10 dit.	64	57	S W	W N W	31			Much light.
2	8A.M.	62	53			18	38 43	74 3	Much light. Thunder-guſt.
—	12	60	53	W S W	N W	18			
—	6 P.M.	64	55	N W	W S W	15			
—	10 dit.	65	55	N b W	W b N	10			
3	7 A.M.	62	54			30	38 30	75 0	

Obſervations of the warmth of the ſea-water, &c. by Fahrenheit's thermometer; with other remarks made on board the Repriſal, Capt. Wycks, bound from Philadelphia to France, in October and November 1776.

Date.		Hour A. M.	Hour P. M.	Temp. of Air.	Temp. of Water.	Wind.	Courſe.	Diſtance.	Latit. N.	Long. W.	Remarks.
Octo.	31	10		76	70	S S E	E b S	135	38 12	70 30	Left the capes Thurſday night, October 29, 1776.
	—		4		71						
Nov.	1	10			78	W S W	E ½ N	109	No ob.	68 12	
	—		4	71	81						
	2	8		71	75	N					
	—	12			78			141	ditto.	65 23	
	—		4	67	76						Some ſparks in the water theſe two laſt nights.
	3	8			76	N W	E S E ½ E				
	—	12			76		E b S	160	37 0	62 7	
	—		4	70	76						
	4	9		68	76		N b E				Ditto.
	—		1		76			194	36 26	58 8	
	—		4	68	76						
	—		8		78						
	5	8		68	76		N E				Ditto.
	—	12		70	75			163	35 21	55 3	
	—		4		75						
	—		8		75						
	6	8			76	E b N	S 50 E				
	—	12			77			75	35 33	53 52	
	7	8			78	S E b E	N 30 W				
	—	12			77			108	36 6	52 46	
	—		4		77						
	8	9		75	77	S b E	N 49 E				
	—	12			77			175	38 2	50 1	
	—		4		77						
	9	9		75	77						
	—	12		75	70	S W	N 33 E	175	39 39	46 55	

Obſervations

Obſervations made on board the Repriſal, continued.

Date.	Hour A. M.	Hour P. M.	Temp. of Air.	Temp. of Water.	Wind.	Courſer.	Diſtance.	Latit. N.	Long. W.	Remarks.
Novem. 9		4		71						
10	8		70	68						
—	12			64	E	N 17 E	64	40 39	46 27	
11	8			63						
—	12			61	S E	N 8 E	41	41 19	46 19	
12	8		56	59						
—		4		69	N N W	N 80 E	120	41 39	43 42	
13	all	day		68	E	S 82 E	69	41 29	42 10	
14	8		70	70		N 74 E	111	42 0	39 57	
—		Noon		72	E S E					
—		4		71						
15	8		61	69						
—		Noon		68	W S W	N 70 E	186	43 3	35 51	
—		4		67						
16		Noon	65	67	S W	N 67 W	48	43 22	34 50	
—		4		63						
17	8			63	E S E	N 19 E	56	44 15	34 25	
18	all	day		65	S b W	N 75 E	210	45 6	29 43	Some gulph weed.
19		Noon	65	64	S W	N 80 E	238	45 46	24 2	
20	8			62	N	S 80 E	155	45 19	20 30	
—		4		60						
21	9			62	S	N 88 E	94	45 22	18 17	
22	10		60	62	S S W	S 89 E	133	45 19	15 19	
23		Noon		61	W S W	S 86 E	194	45 6	10 35	
24		do.		60	N N E	N 78 E	191	45 46	6 10	
25		do.		60	N E	S 76 E	125	45 4	3 23	
26		do.	56	60	E	N 73 E	31	45 13	2 20	
27		do.		58						Soundings off Belliſle.
28		do.	54	56						

1785. A Journal of a voyage from the Channel between France and England towards America.

N. B. Longitude is reckoned from London, and the Thermometer is according to Fahrenheit.

Dates.		Latit. N.		Long. W.		Therm. A.M.		Therm. P. M.		Winds.	Course.	Distance.	Variation of the Needle.		Therm. Noon.	
						Air.	Water.	Air.	Water.			Miles.	West.		A.	W.
July	29					62	57			These are taken on an						
	30					62	58	63	58	average of 24 hours.						
	31					60	58	62	62							
August	1	49	15	4	15	63	62	60	64	East	S W $\frac{1}{2}$ W	60	22°	0		
	2	48	28	8	58	64	64	64	63	E S E	W b S $\frac{1}{2}$ S	174				
	3	47	0	12	13	60	67	omit	ted.	N E	S W b W	160				
	4	45	0	15	43	66	66	do.	66	N W b W	S W $\frac{1}{2}$ W	190				
	5	43	5	17	25	67	65	65	68	N E	S W b S	131	20	0		
	6	41	3	19	44	70	68	71	69	N E	S W $\frac{1}{2}$ S	166	16	30		
	7	38	45	21	34	70	70	68	70	N E	S S W $\frac{3}{4}$ W	165	11	30		
	8	36	42	23	10	72	71	73	72	N E	S S W $\frac{3}{4}$ W	149	11	15		
	9	35	40	25	40	73	73	73	74	N E	W S W $\frac{1}{4}$ S	137				
	10	35	0	27	0	71	73	77	75	N W	W S W $\frac{3}{4}$ S	76				
	11	33	51	28	42	74	74	76	77	North	S W $\frac{3}{4}$ W	112				
	12	33	30	31	30	76	75	76	76	North	W $\frac{3}{4}$ S	143				
	13	33	17	33	32	76	76	78	77	N E	W $\frac{1}{2}$ S	103			77	78
	14	33	22	34	31	76	76	81	79	S S E	W $\frac{1}{2}$ N	50			81	79
	15	33	45	35	0	78	79	79	78	W N W	S W $\frac{1}{4}$ W	35			79	79
	16	34	14	35	30	79	78	81	80	West	N W $\frac{1}{2}$ N	38			81	80
	17	35	37	36	4	80	79	80	78	W S W	N N W	75			80	78
	18	36	7	37	16	80	78	omit	ted.	N W b W	WNW $\frac{1}{2}$ N	65			80	79
	19	36	38	38	0	78	77	78	77	W S W	N W $\frac{1}{2}$ W	49			79	77
	20	37	38	38	6	78	76	omit	ted.	West	N $\frac{1}{4}$ W	62			77	75
	21	36	15	38	26	73	74	78	76	W N W	S b W	82			77	75
	22	35	40	38	44	77	76	80	77	W b S	S S W	38			80	77
	23	35	35	40	52	79	77	78	75	North	W $\frac{1}{4}$ S	100			omit	ted.
	24	35	12	41	31	75	73	75	74	W N W	S W b W	41			75	74
	25	35	40	42	33	79	76	79	76	W b N	WNW $\frac{3}{4}$ N	60			80	76
	26	35	30	42	44	79	76	80	76	S W b W	S W $\frac{1}{2}$ S	14			80	76
	27	35	14	43	23	79	77	81	79	West	W S W $\frac{1}{4}$ S	38			81	78
	28	34	23	44	0	78	76	78	78	N N E	S W b S	60			78	78
	29	34	12	45	52	77	78	78	78	N E	W $\frac{1}{4}$ S	94	8	0	79	78
	30	34	5	48	31	78	78	78	78	East	W $\frac{1}{2}$ S	134			78	78
	31	34	20	51	4	80	79	81	79	East	W $\frac{3}{4}$ S	129			80	80
Septem.	1	34	20	52	47	81	78	omit	ted.	S S W	W $\frac{1}{4}$ N	86			83	80
	2	34	55	55	12	81	80	83	80	S W	W b N $\frac{1}{2}$ W	125			83	80
	3	35	30	57	24	83	80	83	80	S W b S	W b N $\frac{1}{2}$ N	114	6	0	84	81
	4	35	50	59	1	82	80	83	80	S W $\frac{1}{2}$ W	W b N $\frac{1}{4}$ N	82			83	81
	5	35	55	61	0	81	80	82	81	S S W	W $\frac{1}{4}$ N	96			82	81
	6	36	20	62	30	80	81	79	80	N W b N	W b N	75			78	80
	7	34	50	63	10	87	80	78	81	N W b W	S S W	86			78	81
	8	34	45	64	40	75	79	75	79	North	W $\frac{1}{4}$ S	74			75	79
	9	35	[illegible]	66	42	75	79	77	73	N E	W N W	108			78	80
	10	37	20	[illegible]	40	77	73	77	70	E N E	N W	126			78	72

OBSERVATIONS.

July 31. At one P. M. the Start bore W N W. diſtant ſix leagues.

Auguſt 1. The water appears luminous in the ſhip's wake.

—2. The temperature of the water is taken at eight in the morning and at eight in the evening.

—6. The water appears leſs luminous.

—7. Formegas S W. diſt. 32½ deg. St. Mary's S W ¼ S 33 leagues.

—8. From this date the temperature of the water is taken at eight in the morning and at ſix in the evening.

—10. Moonlight, which prevents the luminous appearance of the water.

—11. A ſtrong ſoutherly current.

—12. Ditto. From this date the temperature of the air and water was taken at noon, as well as morning and evening.

—16. Northerly current.

—19. Firſt ſaw gulph weed.

—21. Southerly current.

—22. Again ſaw gulph weed.

—24. The water appeared luminous in a ſmall degree before the moon roſe.

—29. No moon, yet very little light in the water.

—30. Much gulph weed to-day.

—31. Ditto.

Sept. 1. Ditto.

—2. A little more light in the water.

—4. No gulph weed to-day. More light in the water.

—5. Some gulph weed again.

—6. Little light in the water. A very hard thunder-guſt in the night.

—7. Little gulph weed.

—8. More light in the water. Little gulph weed.

—9. Little gulph weed. Little light in the water laſt evening.

—10. Saw ſome beds of rock-weed; and we were ſurpriſed to obſerve the water ſix degrees colder by the thermometer than the preceding noon.

This day (10th) the thermometer ſtill kept deſcending, and at five in the morning of the 11th, it was in water as low as 70, when we ſtruck ſoundings. The ſame evening the pilot came on board, and we found our ſhip about five degrees of longitude a-head of the reckoning, which our captain accounted for by ſuppoſing our courſe to have been near the edge of the gulph ſtream, and thus an eddy-current always in our favour. By the diſtance we ran from Sept. 9, in the evening, till we ſtruck ſoundings, we muſt have then been at the weſtern edge of the gulph ſtream, and the change in the temperature of the water was probably owing to our ſuddenly paſſing from that current, into the waters of our own climate.

On the 14th of Auguſt the following experiment was made. The weather being perfectly calm, an empty bottle, corked very tight, was ſent down 20 fathoms, and it was drawn up ſtill empty. It was then ſent down again 35 fathoms, when the weight of the water having forced in the cork, it was drawn up full; the water it contained was immediately tried by the thermometer, and found to be 70, which was ſix degrees colder than at the ſurface: The lead and bottle were viſible, but not very diſtinctly ſo, at the depth of 12 fathoms but when only 7 fathoms deep, they were perfectly ſeen from the ſhip. This experiment was thus repeated Sept. 11, when we were in ſoundings of 18 fathoms. A keg was previouſly prepared with a valve at each end, one opening inward the other outward; this was ſent to the bottom in expectation that by the valves being both open when going down, and both ſhut when coming up, it would keep within it the water received at bottom. The upper valve performed its office well, but the under one did not ſhut quite cloſe, ſo that much of the water was loſt in hauling it up the ſhip's ſide. As the water in the keg's paſſage upwards could not enter at the top, it was concluded that what water remained in it was of that near the ground, and on trying this by the thermometer, it was found to be at 58, which was 12 degrees colder than at the ſurface.

This laſt Journal was obligingly kept for me by Mr. J. Williams, my fellow-paſſenger in the London Packet, who made all the experiments with great exactneſs.

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